A CONTRIBUTION TO THE STUDY OF CHOREA, WITH SPECIAL REFERENCE TO ITS CONNECTION WITH RHEUMATISM AND HEART DISEASE.

By G. L. Walton, M.D.,
CLINICAL INSTRUCTOR IN DISEASES OF THE NERVOUS SYSTEM, HARVARD UNIVERSITY; PHYSICIAN TO THE NEUROLOGICAL DEPARTMENT, MASSACHUSETTS GENERAL HOSPITAL,

AND

By H. F. Vickery, M.D.,
INSTRUCTOR IN CLINICAL MEDICINE, HARVARD UNIVERSITY; PHYSICIAN TO OUT-PATIENTS, MASSACHUSETTS GENERAL HOSPITAL.

The question of the connection between rheumatism, heart disease, and chorea has been long agitated, but with far from satisfactory results. The problem is by no means so simple as it might at first thought appear. The first question is, whether there be any connection at all between the three conditions—a negative reply to which proposition would dispose of further discussion. Granted, however, there be a connection, is it between rheumatism and chorea, heart disease and chorea, or between all three, as a result of the same pathological condition? In the latter case what is the sequence? That rheumatism leads to heart disease is an established fact. Does the heart disease thereby engendered cause chorea, or does rheumatism cause chorea, the heart disease being merely an accompaniment and in no degree a factor in the etiology?

When we realize that in the great majority of the cases clinicians have had merely the report of the parents to rely on regarding the question of rheumatism, and when, again, we realize the personal equation in estimating the existence of heart disease from given conditions, subjective and objective, the difficulty becomes apparent—a difficulty by no means lessened by the fact that pains in the limbs are frequent in children (so-called growing-pains), and that the designation rheumatism is an extremely convenient one for the practitioner as well as the family to gratify the craving for absolute diagnosis.

The last branch of the question is—given a connection between rheumatism and chorea, heart disease and chorea, or rheumatism *and* heart disease and chorea—What is the nature of the morbid process?

The writers would here disclaim all assumption to the settlement of these points. The object of this paper is rather to discuss, and possibly to offer some suggestions.

In looking over the literature one is struck by the lack of definiteness of statement. Hughes and Bennett,[1] for example, state that out of one hundred and four cases of chorea only fifteen had not had rheumatism or a cardiac murmur. This statement probably embraces cases with either rheumatism or organic or functional heart disease, as well as those having combinations of the three, rendering the statistics far too vague to be of material aid in solving so complicated a problem.

---

[1] Guy's Hospital Reports, 3d series, 1855, vol. i. p. 217.

Another author speaks of cases of acute rheumatism and pains, leaving one again in doubt just what class of cases were included.

The estimates of different writers vary greatly, as may be seen from the following quotations from among them:

Flint[1] states that facts do not warrant the conclusion that the affection is to be described as essentially rheumatic. The most that can be said is that children who have had this disease are apt to become affected with chorea.

Syres,[2] from an analysis of 146 cases, finds that 6.16 per cent. only could be by any possibility attributed to acute rheumatism. He finds, however, rheumatic antecedents, not causal, in 23.97 per cent. and a rheumatic inheritance in 47 cases; the causes assigned by friends in 94 cases being nervous strain (fright, distress, school over-pressure). In 20 cases he found a persistent systolic murmur over the apex, 11 of which cases had had acute rheumatism. A murmur disappearing on recovery existed in 14 cases. He cautions clinicians against mistaking vague pains for rheumatism.

Leroux[3] finds on an analysis of 80 cases 5 with rheumatism—that is, 6¼ per cent.; a mitral murmur in 5, only 1 of whom had had rheumatism, anæmic murmurs in 8.

Steiner, out of 252 cases, finds only 4 in the course of rheumatism, and thinks the difference in statistics must be due to the nationality.

Rhomberg and Grisollo considered rheumatism and heart disease as accidental complications of chorea.

Niemeyer[4] considers the connection between rheumatism and chorea not constant, but states that certainly many cases of chorea have had rheumatism. Certainly, also, heart murmurs often follow rheumatism, even after deducting those due to anæmia and disturbances of nutrition, often enough to determine an endocarditis complicating rheumatism.

Strümpel[5] states that although the statement of certain authors that almost every case of acute rheumatism in children is followed by chorea is far too strong, yet the sequence is comparatively frequent. Chorea is often seen with mild chronic rheumatism, or in valvular cardiac disease with or without rheumatism.

---

[1] Practice of Medicine, 1873, p. 742.

[2] Lancet, Dec. 21, 1889; Archives of Pædiatrics, July, 1890.

[3] Rev. Mens. des Malad. de l'Enf., Juin, 1891.

[4] Pathologie und Therapie, vol. ii. p. 411.

[5] Text-book of Medicine, 1887, American translation, p. 739.

Sée found 61 in 128 cases who had had articular rheumatism, but in only 32 were signs of rheumatism undoubted—that is, 37.65 per cent. doubtful, 25 per cent. certain.

Sturges[1] states that there were only 20 in 100 at the utmost, counting doubtful cases, and in these the rheumatism was the immediate cause in only 3 or 4—that is, 20 per cent. doubtful.

Money,[2] out of 214 cases, found rheumatic fever in 33, rheumatism in 23, doubtful in 9—that is, an undeniable rheumatic history in 16 per cent., possible in 29 per cent.

Ross[3] mentions rheumatism as one of the most frequent and important causes of the disease.

Gowers[4] finds 24 per cent. of rheumatism, and says that heart disease may follow or precede chorea. He finds cardiac disease in three-fourths of the cases where rheumatism existed, and in one-third of those without —that is, in 43 per cent. of the cases altogether.

Ziemssen[5] found 6 cases of rheumatism in 25—that is, over 25 per cent., and draws the conclusion from these observations and those of Copeland, Senhouse, Forgous, Bright, Babington, Hughes, Monckton, Hillier, Romberg, Trousseau, and others that there is a close relationship between chorea and rheumatism.

Senhouse, Heslop, and Roger held that chorea and rheumatism, pericarditis and endocarditis were common expressions of the same pathological process, Roger considering that chorea appeared generally at the decline of the rheumatism.

Perhaps one of the most complete additions to these statistics is that of the committee of investigation from the British Medical Association, the report of which was prepared by Mackenzie, based on 439 cases, resulting in a percentage of 26 per cent. with rheumatism.

Goodall,[6] in an analysis of 262 patients, found 65 cases of systolic, non-organic apex murmur, 33 cases of systolic mitral regurgitant murmur; of which 33 cases 22 had had rheumatic fever. He found 4 cases with similar results together with pericarditis, 3 of which cases had had rheumatic fever; 13 cases of mitral stenosis, 2 of which had had rheumatic fever; 1 of aortic stenosis, with no history of rheumatic fever; 2 cases of double aortic disease, 1 with mitral regurgitation, and 1 with mitral regurgitation and pericarditis; 4 cases of pericarditis without valvular lesion, 3 of which had had rheumatic fever; 10 cases of systolic basic murmur, probably hæmic; 1 case of loud systolic universal mur-

---

[1] Lancet, 1878, vol. ii., p. 283, and 1879, vol. ii. p. 789.

[2] Brain, 1882 and 1883, vol. v. p. 512.

[3] Diseases of the Nervous System, 1883, vol. ii. p. 768.

[4] Ibid., 1888, p. 959.

[5] Pathologie und Therapie, B. xii., H. 2, S. 443.

[6] Guy's Hospital Reports, London, 1890.

mur, with a history of rheumatic fever—that is, 55 cases of valvular organic disease. There were 42 cases of fright; in 5 of these rheumatic fever had existed; 3 cases of imitation, 2 of which had had rheumatic fever; and 8 cases came on very soon after a fall or head injury, 1 of which had had rheumatic fever. There were 10 cases of chorea of pregnancy, 7 of which were married.

We find opinions varying, therefore, all the way from the view that the coincidence of these diseases is mere accident, to that considering them expressions of the same pathological process. Reverting to figures, we find recorded percentages varying all the way from 6 per cent. to 26 per cent. of rheumatism preceding chorea, and of heart disease from 13 per cent. (Syres) to 43 per cent. (Gowers).

It is apparent that no one set of statistics will decide this question, but that many more series of cases must be taken, and that the evidence must finally be carefully weighed, not only as regards quantity, but quality.

The contribution which we would offer toward this end is the careful analysis of 76 cases which we have seen in conjunction during the past two years, most of them at the Massachusetts General Hospital. The number might have been greatly increased had we depended upon cases seen separately, and even have been swelled to over 500, had we trusted to the records in the neurological and general out-patient departments of the Massachusetts General Hospital. We have chosen, however, to place accuracy before numbers.

As regards the neurological branch of this investigation, "habit chorea" was carefully excluded, as well as the choreic movements of hysteria, and those of gross organic disease of the brain—*e. g.*, post-hemiplegic. As regards the investigation of the heart, great pains were taken to distinguish between functional and organic disorders. Weight was not laid upon any single sign exclusively, but the diagnosis was based upon the entire group of objective symptoms—the size of the heart, the presence or absence of a thrill, the location of the murmurs heard and the direction in which they were transmitted, the accentuation or non-accentuation of the pulmonic second sound, and the evidences of venous stasis.

As regards the question of rheumatism, vague pains were not included under rheumatism, even when situated in the joints, but a history of "pain, heat, redness, and swelling," was carefully sought, and only those cases included under rheumatism where the history was sufficiently accurate to render probable the existence of true rheumatic inflammation.

In these 76 cases 36 were found to have no possible history of rheumatism and no question of cardiac disease, either functional or organic —that is, 47.37 per cent. There were found to have had rheumatism without heart disease only 3—that is, 3.94 per cent. Of organic heart disease without history of rheumatism, were found 11 (14.47 per cent.); of both heart disease and rheumatism, 10 (13.16 per cent.); of functional heart disorder 11 (14.47 per cent.); of rheumatism with irregular heart, 5 (6.58 per cent.); of vague pains without rheumatism, 13 (17.10 per cent.). (Out of these 13 cases 3 had organic, 1 inorganic, 1 doubtful heart disease, and the remainder no question of heart disease, being, therefore, also included under these headings.) Two cases had doubtful rheumatic history, and 2 questionable heart disease. One of the cases of organic heart disease was probably congenital.

The total percentage of rheumatism from these statistics is 23.68—closely coinciding with the results of Gowers, Ziemssen, and the committee of the British Medical Association.

The total percentage of organic heart disease is 27.63.

Taking, now, all authorities together, and adding our own observations, we are in position to consider what facts are established, and what are still doubtful.

I. There can be no doubt of the fact that chorea *may* arise without suspicion of either rheumatism or cardiac disease, either functional or organic. Even Hughes and Bennett allow an estimate of 15 out of 104, a proportion which seems low at first sight, but which is by no means startling when we realize the frequency of inorganic heart murmurs in this affection due to anæmia, as well as the frequency of cardiac irregularity resulting from the chorea itself. We have ourselves found over 47 per cent. in which neither rheumatism nor heart disease, organic or functional, existed, nor had existed as far as known; and even if cases of vague pains should be included under rheumatism, the proportion would only be reduced to a little under 40 per cent. These cases, taken together with many authenticated instances of chorea produced by fright or other emotional excitement without question of rheumatic or cardiac origin, lead to the establishment of the fact that neither of these conditions is essential to the production of chorea.

II. The preponderance of evidence up to this time points to the fact that both rheumatism and organic heart disease are found more frequently in the present or past experience of choreic patients than can be accounted for by mere coincidence. As stated above, we have found, out of 76 cases, a distinct history of rheumatic fever without heart disease in 3; with organic heart disease in 10; with inorganic heart disease in 5; and a doubtful history of rheumatism in 2—making a total of 18 quite certain (23 per cent.), and 2 doubtful cases—certainly a very large proportion for a coincidence.

It may also be said of the statistics of others, taken as a whole, considering the number of observers, the number of cases, and the quality of the work, that the preponderance of evidence carries the average observation considerably beyond the limit of coincidence.

Again, in our 76 cases 11 had organic heart disease without rheumatism, in addition to the 10 already mentioned, in which they existed together, making a total of 22 with organic cardiac disease—again a large proportion for coincidence, as well as too many to admit of the supposition that the heart disease was a complication merely coincident to the rheumatism. In 2 more cases there was question of organic heart disease, and in 11 more inorganic heart disease existed without rheumatism.

Other authors have not furnished so exact statistics on the condition of the heart as on the question of rheumatism; but Gowers, above quoted, finds it present in three-quarters of the cases with rheumatism and one-third of the cases without, making a total of 43 per cent.—a still higher percentage than our own. As an example of a lower proportion may be noted Syres, quoted above, who finds 13.69 per cent. with structural cardiac disease and 43.8 per cent. with heart affection other than organic. But this proportion even exceeds the limit of coincidence, as, surely, not 13 per cent. of cases taken promiscuously from the records of children under hospital treatment for other diseases would be found to have organic heart disease.

Further figures upon this point are more needed than upon the question of rheumatism, but, on the whole, it seems to us that the proportion already gathered from the literature points in the same direction as our results.

Far from being biased in our investigation by previous statistics, it is only fair to say that we started out with a preconceived idea that, on the whole, the connection between these diseases had been considerably overrated, an *à priori* view which our facts have led us to modify materially.

Again, among the fatal cases of chorea, nearly all have been found, on post-mortem examination, to have organic heart disease.

Goodall found that in eleven fatal cases all had valvular disease of the heart.

Watson found that ten out of twelve fatal cases had organic cardiac disease.

The preponderance of evidence, on the whole, is in favor, then, of the theory that some connection exists between both rheumatism and heart disease, independently considered, and chorea.

The numerous cases in which the three affections have appeared in stormy fashion, either simultaneously or closely following one another, tend to show that this view is applicable to one class of cases, though not to all.

A single illustrative case may be adduced, seen by both the writers in consultation with Dr. F. B. Harrington.

CASE.—R. L., a girl, aged five years. A month ago was attacked with rheumatic fever, with swelling of the knees and ankles, and pain so severe as to prevent motion. Extreme dyspnœa supervened and rapidly increased. Prominence of the left thorax was soon visible. A few days later universal choreic movements appeared and became rapidly violent, affecting speech and deglutition. Examination of the heart showed a rapid, irregular, and feeble action, with enlargement of the area of cardiac dulness, a systolic and presystolic murmur at the apex, with presystolic thrill at the apex, and accentuation of the pulmonic second sound. In addition to these signs there was a harsh to-and-fro murmur along the left edge of the sternum, near to the ear of the listener, undoubtedly due to pericarditis.

Death ensued within a week; no autopsy was made.

This is a typical case of that form of chorea which terminates fatally, organic heart disease being found in the majority of such cases, as we have said. It is unfortunate that no autopsy could have been made on the central nervous system, but a sufficient number of autopsies have been made, in such cases, to render it extremely probable that organic changes (emboli) were present in the brain.

This brings us to the question—granted a connection between these diseases—What is its nature, and, in general, what is the pathology of chorea? Is any one pathological theory applicable to all cases, as many authorities have endeavored to show?

Among the changes found in fatal cases may be mentioned—*a*, emboli, varying from minute and scattered to those of appreciable size, in the cerebrum, more particularly in the gray matter of the cortex and basal ganglia (Gray, Elischer, Broadbent, Tuckwell); *b*, hydrocephalus; *c*, meningeal hyperæmia; *d*, hemorrhages; *e*, softening; *f*, hyperplasia of connective tissue and proliferation of nuclei; *g*, alterations in the vessels and perivascular regions; *h*, perivascular infiltration in the medulla and pons, with slight hemorrhages (Nauwerk); *i*, dilatations of minute arteries in the brain and cord, especially in the corpus striatum and thalamus, with hemorrhages (Broadbent); *j*, degeneration of cortical cells (Meynert); *k*, degeneration of nerve elements in the corpus striatum (Elischer).

Changes have also been found in the spinal cord and peripheral nerves;[1] not, however, with a sufficient constancy to draw our attention from the brain as the principal seat of disturbance, more particularly those portions of the brain composing or surrounding the motor tract.

Let us now review briefly some of the theories of the pathology of chorea.

Kirk supposes that inflammatory products from the cardiac valves, mingling with the blood, disturb the functions of the central nervous system. This is somewhat vague, and it would seem rather that, in such case, some definite lesion in the vascular system, multiple perhaps, but tangible, must be produced by these inflammatory products, especially when we remember the unilateral nature of the chorea frequently associated with cardiac disease, not only the choreic movements involving one side, but also the paresis.

---

[1] The experiments of Legros and Onimus, in 1870, pointed toward a spinal origin in dogs; such observations have not received sufficient confirmation to affect materially the above conclusion.

Broadbent[1] considers the choreic movements due to widely spread hyperæmia of the nervous centres; of this we have no more evidence than we have that persistent anæmia produces the incoördinate movements by lowering the vitality of the cerebral cells.

The same author mentions the suggestion that hyperæmia with capillary blood stasis or capillary thrombosis by cohering leucocytes may be accountable for the disturbance, but neither blood stasis nor thrombosis is a constant condition in chorea.

Again, it has been suggested that prolonged arterial spasm from persistent reflex irritation (uterus or intestines) may lower the functional vigor of the ganglia. This theory is allied to the vasomotor theory of hysteria, and has a certain plausibility, but is, of course, purely conjectural.

Joffroy[2] considers chorea a cerebro-spinal neurosis of development, or disease of growth. He says: "It is to the nervous system what chlorosis is to the vascular."

Gowers inclines to the old theory that a morbid state of the blood, probably chemical, produces both endocarditis and chorea—a state probably allied to that producing rheumatism. Of the mechanism by which the abnormal blood state produces chorea, he states, we are ignorant, but he considers that a certain receptivity of the central nervous system is an essential prerequisite.

Koch considers chorea an infectious disease, and states that the choreic virus may produce either rheumatism or choreic endocarditis.

Sturges supposes a purely functional pathology, an activity in excess of the stability of the nervous system—in other words, lack of establishment of the lines of resistance.

J. Lewis Smith lays stress upon intestinal and uterine disorders, as well as upon anæmia, the "neuropathic state," as fright and imitation among the causes of functional chorea, but also considers rheumatism and heart disease important factors, and calls attention to the fact that organic heart disease may exist without murmurs.

The effort among most authors seems to be to adapt one explanation to all cases. But are the comparatively few fatal cases to fix the pathology for all forms of the disease, and are we to assume, as suggested by Ziemssen, that in the milder cases a minor degree of the same pathological process exists? and conversely, are we to assume that all cases are functional? The former supposition seems hardly satisfactory when the comparatively mild course of the average case under arsenical treatment is considered. In the Nervous out-patient department of the Massachusetts General Hospital, where this treatment is pushed in practically every case from the outset, among the extremely numerous examples of this disease it is rare to find a case severe enough to furnish the students a satisfactory illustration of the subject. Just how arsenic should dispel such serious pathological conditions as above mentioned, it is difficult to understand. Nor, again, does it seem quite satisfactory to suppose the change in fatal cases is a purely functional one. It seems rather that we must recognize two quite distinct classes of this disease, the one with a definite organic basis, the other functional.

---

[1] Quain's Dictionary of Medicine, 1889.

[2] Sajous's Annual, 1889.

As regards the mechanism of the abnormal mobility we are, as Gowers states, still in the dark, and it is perhaps premature for anyone to offer conjectures at this stage of our knowledge. We shall certainly make no endeavor in this direction.

That the disease may, in certain cases, be purely functional is rendered more than probable by the universally recognized cases of chorea appearing during the event of menstruation, and recurring at childbirth; again, by the cases, to which allusion has already been made, produced by fright or trauma. In the former cases the process is probably purely reflex to uterine disturbance, in the latter set up by psychical irritability without organic change. In many of these cases the thought would suggest itself that choreic movements, like infantile convulsions, migraine, and other functional disorders, may be often purely reflex—a symptom rather than a disease. This idea has been carried to an extreme by Stevens, and others who have followed him. This author apparently regards most cases of chorea, as well as epilepsy and migraine, as secondary to eye-strain. While the clinical results of treatment have not established this view, and while from an *à priori* standpoint it might be questioned whether the irregularity of action of the ocular muscles were not rather, like that of the cardiac muscle, a result rather than a cause of chorea, certain cases have undoubtedly been relieved by proper ocular treatment, as Dr. Cheney has also shown.

The abandonment of this view as extensively applicable does not, however, preclude the idea that chorea may be often reflex, though not merely to eye-strain. Persistent hiccough, convulsions, vomiting, and other symptoms of cerebral irritability, are recognized as often reflex to disease of other localities, and, to recur to the question of rheumatism, the idea advanced by Dr. Cheney, that chorea may possibly be set up sometimes as a reflex to joint disease, is worthy of consideration. In early life, before the adult inhibitory processes have become established, comparatively slight irritation in certain localities certainly suffices to produce marked cerebral symptoms, and it is not impossible that the joints may prove to be among these localities. In fact, a certain alliance between rheumatism and functional nervous disease has long been recognized. The tendency for both affections to occur in the same family has been pointed out, especially by Féré. Some authors have called attention to the cerebral symptoms not infrequently associated with rheumatism, and the term cerebral rheumatism has even been applied by some clinicians, though the writers would by no means commit themselves to a belief in such a condition as a distinct entity.

The atrophy of muscles, frequently associated with rheumatism, should not be forgotten, as pointing to a neuropathic element in this disease; this atrophy being, as Strümpel first pointed out, far too marked to be explained by mere disuse—the term joint-atrophies, proposed by this writer, having been now universally adopted.

Again, the rapidity with which rheumatism changes its location, points to a nervous element in its pathology.

The objection to the theory of joint reflex is that the chorea generally appears as a sequel to, rather than during the attack of rheumatism. It is not impossible, however, that rheumatism and chorea are manifestations of the same neuropathic tendency.[1]

Assuming the possibility of chorea as a reflex to rheumatic inflammation, shall we also suppose a reflex chorea may be dependent on organic heart disease? for we have still a large proportion of cases where heart disease existed without rheumatism—too large a number, as we have already stated, to be explained by mere coincidence. This can hardly be regarded as probable. It is far more probable that those cases where organic heart disease alone exists should be entirely removed from the question of reflex causation, and classed either among the cases with probable organic cerebral basis in varying degree—that is to say, emboli and other vascular disturbances, or among those where depletion of blood produces weakness and irritability of cerebral nerve-cells.

The preponderance of female patients, both during the advent of menstruation and throughout adult life, certainly points to a functional origin, in a large class of cases, at least. Koch finds, for example, 167 females to 100 males (three to two). Gowers finds over five to two in a collection of 1365 cases of his own and others. Broadbent finds chorea more than twice as frequent in females as in males, especially after the age of nine. Goodall finds 188 females to 74 males (five to two). Our own statistics on this point, taken from 490 cases in the records of the

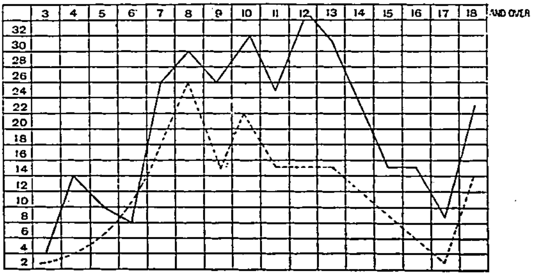
---

[1] M. F. Cox: Sajous's Annual, 1890. Duckworth: Liverpool Med.-Chir. Journal, July, 1891.

Neurological department of the Massachusetts General Hospital, shows 300 females to 190 males, or about three to two—closely approximating the observations of Koch.

The following chart is instructive in connection with the question of chorea as a reflex. This chart represents the comparative ages of onset of chorea in boys and girls—taken from the 490 cases already mentioned. From this it is evident that the maximum age in boys is between seven and eight, the line falling rapidly from this point.

The dotted line represents males; the continued line, females. The ages are at the top, the number of cases at the left. In girls the line continues high until the age of twelve to thirteen, then falling, there being twice as many girls at the age of thirteen as boys, whereas the number at eight is the same in both boys and girls. This would point to the fact that the additional number of cases in girls, as compared with boys, is due entirely to those arising during, or after the age of puberty. It is also worthy of note that many more females have chorea in adult life than males. According to our statistics, there were 22 cases of chorea occurring at eighteen or over in females, 13 in males; this proportion being greater than that of the absolute number of females to males, which was three to two. A similar chart may be made from the cases of Goodall, previously quoted, although the maximum age in boys was ten in Goodall's results, instead of seven to eight, as in ours. The curve in Goodall's cases, however, rises rapidly from ten through twelve in females, whereas it falls directly from ten in males.



CONCLUSIONS.

1. Neither rheumatism nor heart disease is essential to chorea.

2. The preponderance of evidence points toward the conclusion not only that rheumatism and organic heart disease conjointly appear more fre-

quently in the choreic subject than can be accounted for by coincidence, but that the same is true of each of these affections separately. It follows, therefore, that (*a*) rheumatism predisposes to chorea, and (*b*) organic heart disease has the same tendency.

3. (Drawn from the observation of others.) Fatal cases are generally associated with organic heart disease, and probably with organic disease of the central nervous system (notably cerebral emboli).

4. There is a large class of functional cases—largely reflex, and fostered by circumstances tending to produce functional symptoms in general.

5. The pathological connection betweeen rheumatism and chorea, excepting in the cases where emboli are produced by accompanying endocarditis, is still obscure; probably no one theory is applicable to all cases.

6. The mechanism by which the peculiar phenomena of chorea are produced is unknown.

UNUNITED FRACTURES IN CHILDREN.

By D'Arcy Power, M.A., M.B. Oxon., F.R.C.S. Eng.,
DEMONSTRATOR OF SURGERY AT ST. BARTHOLOMEW'S HOSPITAL; SURGEON-IN-CHARGE OF OUT-PATIENTS AT THE VICTORIA HOSPITAL FOR CHILDREN, CHELSEA.

The subject of fractures is one which has always had a peculiar interest for American surgeons, and the literature in connection with it is therefore very extensive. As I do not find that any surgeon has paid especial attention to ununited fractures occurring in children, I have thought it worth while to put a few notes together, which I hope may prove useful as well as interesting to those surgeons who are attached to children's hospitals, or who are otherwise brought into frequent contact with children who have sustained injury.

Ununited fractures are undoubtedly rare in children, but nearly every surgeon who has much to do with the treatment of the surgical diseases of children can probably recall one, or perhaps more cases of non-union which have come under his notice. Some of them have been published in the various medical periodicals of the world, and I have recently been at the trouble of collecting and tabulating some of the more accessible.

In the unrivalled collection of cases of ununited fractures compiled by Dr. Frank Muhlenberg, and published in the first volume of Professor Agnew's *Principles and Practice of Surgery*, no less than 685 cases are recorded and analyzed. This table includes pseudarthrosis met with at all periods of life, and amongst them I find 28 cases occurring in children under ten years of age. Sir James Paget[1] records 3 cases which

---

[1] Studies of Old Case-books, London, 1891, pp. 130–135.